

Preliminary field survey of butterflies on Xishan Hill (Kunming, Yunnan Province, China)

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Abstract. The survey recorded 80 butterfly species on Xishan Hill, including eight species listed on the "China Species Red List (IUCN List)." Of the species found, 51.3% are of Oriental origin, 40.0% are cosmopolitan, 6.3% are Palearctic and 2.5% are endemic to Yunnan. Pieridae and Nymphalidae are the best represented families on the hill. Among nine surveyed habitat types, edges of the primary forest and open grassland shrubs are the two most favored areas. Amongst available nectar sources Asteraceae species were most visited. Information on active periods and non-floral food was recorded. Unlike with previous studies in this area, this survey provides information concerning ecological aspects besides a checklist.

Key words: butterflies, species, taxonomic composition, faunal composition, habitat types, habitat affinities, active periods, feeding habits, checklist.

INTRODUCTION

Butterflies are conspicuous insects in Yunnan Province, represented by over 600 recorded species (Lee, 1995). Prior work showed that Yunnan butterflies appear to consist of: 330 Oriental species (76.4%), 39 Palearctic species (9.0%), 63 species (14.6%) considered to be cosmopolitan, and 91 species which are (21.1%) endemic to Yunnan (Li, 1996). This community represents a distinct highland butterfly fauna.

Based on the climatic and plant community characteristics, the Yunnan butterfly fauna can be further divided into three subregions and many corresponding districts: (1) the tropical rainforest and monsoon forest subregion, including Hekou District, Jinghong District, Mengding District, and Ruili District; (2) the subtropical evergreen broadleaf forest, coniferous, and broadleaf-coniferous mixed forest subregion, including Nanpanjiang River District, Lancangjiang River District, Qujing District, and Jinshajiang River District; and (3) the temperate coniferous forest subregion, including Hengduanshan Mountain District and Zhaotong District (Li, 1996).

Kunming belongs to the second of these three. From its northern to its southern parts, Kunming is located between the Nanpan River district and Qujing district. The mean elevation is 2,000 m, with hills and low mountains. Annual mean temperature is 12~17°C; annual mean rainfall is 1,300mm (Li, 1996).

Xishan Hill lies 15 km southwest of Kunming, beyond Dianchi Lake. Xishan Hill, with an altitudinal transition from 1,900 m to 2,356 m and microclimate shift occurs with this altitudinal transition. Xishan Hill has a complicated ecology which is able to sustain a broad diversity of plants, insects, birds, and mammals. The original forests were composed of *Cyclobalanopsis glaucooides* (Wu & Raven, 2001, 2003), *Quercus variabilis*, *Q. aliena*, *Alnus nepalensis*, *Keteleeria evelyniana*, *Michelia yunnanensis*, *Pyracantha fortuneana*, *Rhododendron* sp., *Myrica nana*, and *Piris formosa* (Wu *et al.*, 1987). Secondary forests are composed of pine trees and cypress trees. In addition, patches of farmlands exist. The mosaic of plant diversity provides for the rich butterfly community on the hill.

The recorded community of butterflies on Xishan Hill was 77 species with the following taxonomic composition: four species (5.2%) of Papilionidae, 20 species (26.0%) of Pieridae, five species (6.5%) of Danainae, 11 species (14.3%) of Satyrinae, 19 species (24.7%) of Nymphalinae, three species (3.9%) of Riodinidae, eight species of (10.4%) Lycaenidae, and seven species (9.0%) of Hesperidae (Lee *et al.*, 1995). The Acraeinae was included in family Nymphalinae at that time by Preston-Mafham and Rod (1988) who also regarded the several subfamilies of Nymphalidae as families. The present field survey here emphasizes on the ecological aspects of butterflies.

MATERIALS AND METHODS

Field Sites

The field survey was carried out in the forest areas

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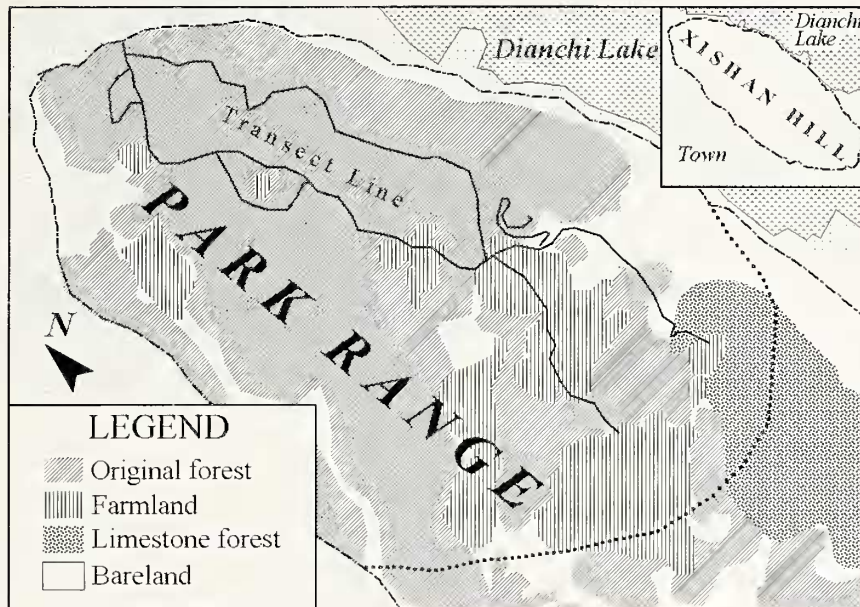


Figure 1. Map of surveyed area.

on Xishan Hill (Fig. 1), mainly along the paths in Maomao Qing and the backyard of Huating Temple. Additionally, many turnoffs and farming patches deviating from the paths were surveyed. All are shown as the transect in Fig. 1.

Collecting methods

I walked an 18 km transect route with an altitudinal transition from 1,900 m at the foot to 2,342 m once a week from mid May to late August in 2001, from early July to late September in 2002, from late February to late April in 2003, from mid June to mid October in 2005, and from early March to mid November in 2007. The field survey had a cumulative total survey time of 470 hours.

Butterflies were caught in flight with nets, at rest on attractants, or on the ground. Traps baited with rotting bananas and mangos were used to trap some nymphalines and satyrines with every trap checked at the end of the weekly field survey. All of the collected butterflies were killed with ethyl acetate and stored in paper envelopes for later identification and as vouchers.

Plant specimens were collected with butterflies when needed. Appropriate parts (flowers, leaves, or fruits) were collected or photographed for identification.

Geographical data were recorded by a GPS device (Garmin eTrex Vista [v 3.2]).

Specimen identification

Most butterflies were identified by sight when obvious. Undetermined specimens were later compared with determined specimens from my private collection or with field guide illustrations. Problematic specimens which did not match were studied further by microscopic observation of the adult male external genitalia.

Well known and familiar plants were identified directly in the field, but most identification was done in the laboratory using literature manuals or colleagues' help.

RESULTS

The collected and recorded materials are presented with a series of tables and charts.

Habitat types

I partitioned and classified nine types of habitats, from 1,900 m to 2,340 m as follows:

(1) Dense primary forest: Dominants are *Pinus yunnanensis*, *Keteleeria evelyniana*, *Alnus nepalensis*, and *Cyclobalanopsis glaucoides*. The community shows less sunlight, but higher relative humidity than the following habitat types. The understory of this habitat has grasses and bushes, especially *Eupatorium adenophorum* and *Myrica nana*.

Table 1. Taxonomical and faunal compositions of surveyed species.

| Family | Species | Faunal catalogue | | | |
|--------------|---------|------------------|----------|--------------|---------|
| | | Palaearctic | Oriental | Cosmopolitan | Endemic |
| Papilionidae | 10 | | 4 | 6 | |
| Pieridae | 17 | 2 | 5 | 10 | |
| Danainae | 6 | | 4 | 2 | |
| Satyrinae | 13 | | 8 | 3 | 2 |
| Nymphalinae | 17 | 1 | 8 | 8 | |
| Acraeinae | 1 | | 1 | | |
| Riodinidae | 2 | | 2 | | |
| Lycaenidae | 7 | | 5 | 2 | |
| Hesperiidae | 7 | 2 | 4 | 1 | |
| Subtotal | 80 | 5 | 41 | 32 | 2 |

(2) Primary forest edge: the edge area of adjoining patches of forest has a higher diversity, exemplified by shrubs and herbaceous plants such as *Gynura segetum*, *E. adenophorum*, *E. fortunei*, *Bidens pilosa*, *Taraxacum sp.*, *Pyracantha fortuneana*, *Michelia yunnanensis*, *Rhododendron sp.*, *Piris formosa*, and *Vicia cracca*.

(3) Open bare land: this type of habitat has little vegetation being mainly dust, sand and small rocks. When the dust mixes with water, the dissolved mineral salt attracts many nymphalines and skippers. Also the high morning temperature at these sites appears very attractive to butterflies during morning hours.

(4) Open farmland: crops here are mainly *Raphanus sativum* and *Brassica campestris* usually with many *Vicia cracca* vines among the crops. The crops are host plants of some pierids and their flowers also produce quantities of nectar that attracts butterflies. Many *Pieris sp.*, *Papilio sp.*, and lycaenids like *Heliophorus brahma* were noted.

(5) Open fields with grasses and shrubs: this habitat is complex with high floral diversity (where not invaded by *E. adenophorum*). The lower stratum consists of grasses and some small herbs as *Taraxacum sp.*, *Rhododendron sp.*, and *V. cracca*. The middle stratum is tall grasses and the upper stratum is a community of *G. segetum*, *P. fortuneana* shrubs and some *M. yunnanensis*. Flowers of these plants provide rich nectar sources.

(6) Dry valleys: these places are exposed to high sunlight, but low humidity, especially with southern exposures. Consequently, few xerophytes plants occur that can tolerate water deficiencies, i.e communities of *Bidens pilosa*, *Rhododendron sp.*, *Cephalanoptos segetum* and *Taraxacum sp.*. The major groups of associated butterflies are some lycaenids and nymphalines and a

few satyrines. A few swallowtails were seen but not taken.

(7) Valley with water sources: such sites are always hot and dry, so any water may attract many insect species. Wherever streams flow many swallowtails, pierids, nymphalids, riodinids, lycaenids, and skippers are present.

(8) Open sites with water: as valleys with water the sites are attractive to most butterflies.

(9) Shaded places: shaded places have their own butterfly groups that avoid sunlight. For example, riodinids and satyrines are present in shaded areas more than in other habitats.

The detailed relationship between butterfly species and habitat types are given in Fig. 3, Appendix 1.

Checklist and Red List species

During the cumulative field work on Xishan Hill, I collected 80 species of butterflies which are included in all six butterfly families (Appendix 1), all of which have been identified (Chou, 1994, 1998).

All of species were catalogued by two characteristics: faunal and taxonomic composition. The faunal composition is: 6.3% Palaearctic species, 51.3% Oriental species, 40.0% cosmopolitan species, and 2.5% species endemic to Yunnan (Chou, 1994). Taxonomic composition is: 12.5% Papilionidae, 21.3% Pieridae, 46.4% Nymphalidae (7.5% Danainae, 16.3% Satyrinae, 21.3% Nymphalinae, 1.3% Acraeinae), 2.5% Riodinidae, 8.8% Lycaenidae, and 8.8% Hesperiidae. These are cited in Table 1, Fig. 2.

Among the collected butterflies are eight species

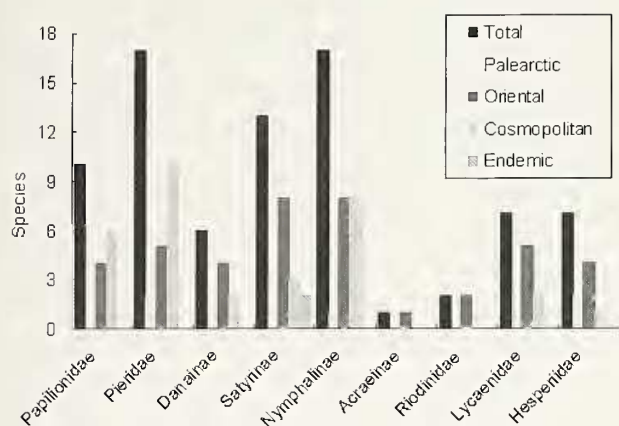


Figure 2. Taxonomical and faunal compositions of each family and subfamily.

Table 2. Species listed on the Red List.

| Species | Categories |
|---------------------------|------------|
| Papilionidae | |
| <i>Byasa hedistus</i> | VU |
| Pieridae | |
| <i>Hebomoia glaucippe</i> | NT |
| Satyrinae | |
| <i>Ypthima nikawa</i> | NT |
| <i>Lethe anderson</i> | NT |
| <i>Ypthima sakra</i> | NT |
| <i>Ypthima iris</i> | VU |
| <i>Ypthima dromon</i> | VU |
| Hesperiidae | |
| <i>Lobocla proxima</i> | NT |

Categories: VU: vulnerable, NT: near threat

listed on the "China Species Red List" Table 2 (Wang & Xie, 2005).

Active period

The butterflies of Xishan Hill showed clear and distinct active periods within groups (Table 3). *Papilio xuthus*, *Colias erate*, *Pieris sp.*, *Vanessa sp.*,

Dodona durga and *Heliophorus brahma* are the earliest emerged species in early spring (late February). *Pieris sp.*, *Vanessa sp.*, *Lampides boeticus*, and *Celastrina oreas* are the last surviving species by early winter (early November). Most species were flying in March and were absent in October. Danaines were first seen in April and skippers appeared in May. *Acraea issoria* appeared over less than three months, from late July to early September, but the data are based on only two female specimens. For most species there is a gap between spring and summer generations. In May, only few adult butterflies were flying, and some species disappeared temporarily. These gaps may well be due to sparse data and annual variation.

Habitat affinities

As mentioned above, nine habitat types were classified for the field survey. My conclusions on habitat affinities were based on observed butterfly species collected in each of these habitats.

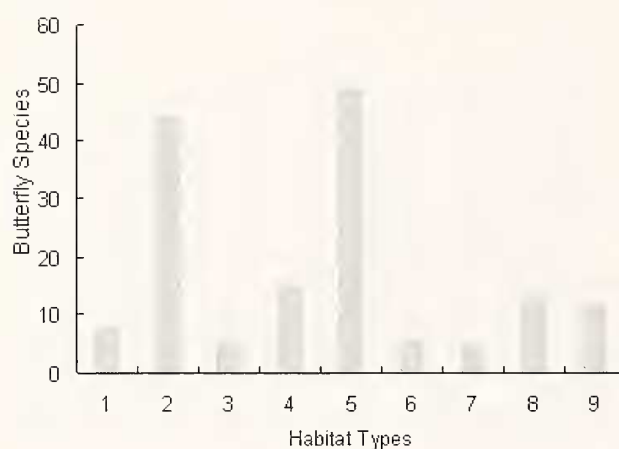
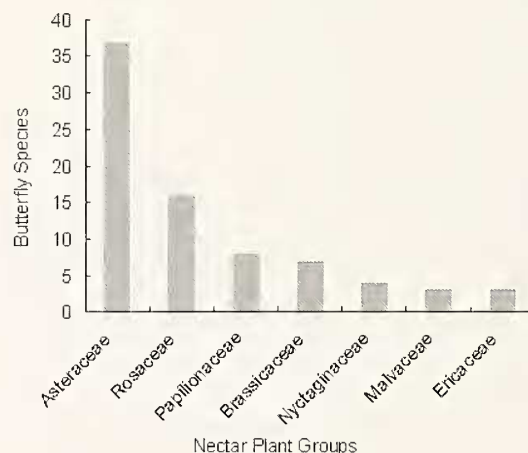
The edges of primary forest and open space with predominant grasses and shrubs are the favored habitats, the likely result of high vegetation diversity along the edges that provide the greatest number of host plants for early stages. Open land with many shrubs provides adults with rich nectar sources. Many swallowtails, pierids, danaines, lycaenids, and skippers are found in these habitats in addition to a few nymphalines and satyrines. Habitats with the lowest butterfly abundance and diversity are dry places as open bare land and dry valleys. In these places, I only found *Vanessa sp.*, *Dodona durga*, and *Heliophorus brahma* during early morning hours. Dense forest and shaded places share common characteristics in spite of vegetational differences: lower sunlight, lower temperature, and higher relative humidity. Satyrines, especially the rarely seen *Lethe spp.* and *Neope yama*, are most common in these sites. Sites with water always provide for some butterflies during the summer, with the most common species being *Byasa polyeuctes*, *Papilio bianor*, *P. xuthus*, *Delias belladonna*, and *Aporia agathon*. Farmlands are special and most usually monoculture plantations of *Brassica campestris* and *Raphanus sativus* that provide fragrance and nectar during summertime.

Feeding behavior

Butterflies which prefer flowers include all the swallowtails, all the pierids, all the danaines, plus a representation of satyrines, nymphalines, lycaenids, and skippers. Most butterflies across the study site feed on flowers. Among them, a diversity of nectar plant

Table 3. Major active periods of butterflies in each family and subfamily.

| Butterfly families | Months | | | | | | | | | |
|--------------------|--------|---|---|---|---|---|---|---|---|---|
| | F | M | A | M | J | J | A | S | O | N |
| Papilionidae | X | X | X | | X | X | X | X | X | |
| Pieridae | X | X | X | X | X | X | X | X | X | X |
| Danainae | | | X | | X | X | X | X | X | |
| Satyrinae | | X | X | X | X | X | X | X | X | |
| Nymphalinae | X | X | X | | X | X | X | X | X | X |
| Acraeinae | | | | | | X | X | X | | |
| Riodinidae | X | X | X | X | X | X | X | X | X | |
| Lycaenidae | X | X | X | | X | X | X | X | X | X |
| Hesperiidae | | | | X | X | X | X | X | X | |

**Figure 3.** Relation between species abundance and habitats.**Figure 4.** Visitation rate of major nectar plants by family.

preferences obviously exists (Table 4). Swallowtails prefer *Eupatorium spp.* and *Rhododendron spp.* Sometimes they also feed on *Vicia cracca*, *Bougainvillea glabra*, and *Hibiscus mutabilis*. Danaines prefer various Asteraceae plants which give off powerful odors, especially *Gynura segetum*. Pierids prefer farming patches, as these provide many flowering legumes, cabbages, and radishes. The remaining groups prefer flowers of small plants, including *Taraxacum sp.*, *Crepis sp.*, *Youngia sp.*, and *Potentilla fulgens* (Fig. 4).

Only a few butterflies showed a preference for non-floral attractants (Table 5). The commonest attractants were organic substances containing various acids, including rotting fruits, feces (mainly horse feces and urine), and all manner of rotting organic garbage dumped by tourists. Most nymphalines, satyrines, and lycaenids were attracted to rotting

materials. Mud also attracted many butterflies during hot summer days.

DISCUSSION

The 80 surveyed species were collected in the areas adjacent to the routes randomly taken by insect net and in traps. There were a few areas not investigated, and their specialized species could be absent from the checklist. It should also be recognized that there were two possibly incorrectly named species among those surveyed, based upon comparison of the male genitalia with available illustrations. The two species were identified as *Heliophorus brahma* and *Ahlbergia chalcidis* (Wang & Fan, 2002).

Graphing cumulative species number against

Table 4. Species collected or observed on flowers.

| Plant species | Butterfly species |
|--|---|
| Asteraceae | |
| <i>Eupatorium fortunei</i> | <i>Byasa polyeuctes</i> , <i>B. hedistus</i> , <i>B. nevilli</i> , <i>Papilio xuthus</i> , <i>P. polytes</i> , <i>P. bianor</i> , <i>Parantica sita</i> , <i>P. melanaea</i> , <i>Tirumala septentrionis</i> , <i>Euploea mulciber</i> |
| <i>Eupatorium adenophorum</i> | <i>Papilio xuthus</i> , <i>Pieris brassicae</i> , <i>Pontia daplidice</i> , <i>Aporia agathon</i> , <i>Ypthima balda</i> , <i>Neptis hylas</i> , <i>Lampides boeticus</i> , <i>Potanthus pallida</i> , <i>Ochlodes subhyalina</i> |
| <i>Gynura segetum</i> | <i>Byasa nevilli</i> , <i>Papilio syfanius</i> , <i>Danaus genutia</i> , <i>Parantica melanaea</i> , <i>Tirumala septentrionis</i> , <i>Euploea mulciber</i> , <i>Acraea issoria</i> |
| <i>Cephalanoplos segetum</i> | <i>Papilio xuthus</i> , <i>Appias remedies</i> , <i>Danaus chrysippus</i> , <i>Chilodreia childreni</i> , <i>Vanessa cardui</i> , <i>V. indica</i> |
| <i>Taraxacum</i> sp. | <i>Pieris napi</i> , <i>P. melete</i> , <i>P. rapae</i> , <i>Ypthima balda</i> , <i>Y. iris</i> , <i>Y. nikaia</i> , <i>Callerebia suroia</i> , <i>Heliophorus brahma</i> , <i>Zizina otis</i> , <i>Celastrina oreas</i> , <i>Lampides boeticus</i> |
| <i>Crepis</i> sp. / <i>Youngia</i> sp. | <i>Zizina otis</i> , <i>Lampides boeticus</i> , <i>Tongrea ion</i> |
| Papilionaceae | |
| <i>Vicia cracca</i> | <i>Papilio xuthus</i> , <i>Colias erate</i> , <i>C. fieldii</i> , <i>Pieris rapae</i> , <i>Lampides boeticus</i> |
| <i>Trifolium repens</i> | <i>Ypthima sacra</i> , <i>Zizina otis</i> , <i>Tongrea ion</i> |
| Rosaceae | |
| <i>Potentilla fulgens</i> | <i>Ypthima balda</i> , <i>Y. iris</i> , <i>Zizina otis</i> , <i>Celastrina oreas</i> , <i>Lampides boeticus</i> , <i>Potanthus pallida</i> , <i>Cartocephalus alcinoide</i> , <i>Ochlodes subhyalina</i> , <i>Pyrgus maculatus</i> |
| <i>Pyracantha fortuneana</i> | <i>Aporia agathon</i> , <i>Aglais urticae</i> , <i>Heliophorus brahma</i> , <i>Ahlbergia chalcidis</i> , <i>Celastrina oreas</i> |
| <i>Spiraea martinii</i> | <i>Ixias pyrene</i> , <i>Gonepteryx amintha</i> , <i>Symbrenthia hypseis</i> |
| Nyctaginaceae | |
| <i>Bougainvillea glabra</i> | <i>Papilio syfanius</i> , <i>P. bianor</i> , <i>P. polytes</i> , <i>P. xuthus</i> |
| Brassicaceae | |
| <i>Brassica campestris</i> | <i>Colias erate</i> , <i>C. fieldii</i> , <i>Pieris napi</i> , <i>P. melete</i> , <i>P. rapae</i> , <i>Eurema hecabe</i> , <i>Heliophorus brahma</i> |
| <i>Raphanus sativus</i> | <i>Colias erate</i> , <i>C. fieldii</i> , <i>Pieris rapae</i> , <i>Heliophorus brahma</i> |
| Malvaceae | |
| <i>Hibiscus mutabilis</i> | <i>Byasa hedistus</i> , <i>Papilio bianor</i> , <i>P. syfanius</i> |
| Ericaceae | |
| <i>Rhododendron</i> sp. | <i>Dodona durga</i> , <i>Heliophorus brahma</i> , <i>Ahlbergia chalcidis</i> |
| <i>Piris formosa</i> | <i>Dodona durga</i> , <i>Heliophorus brahma</i> , <i>Ahlbergia chalcidis</i> |

working time (Fig. 5) provides a curve of sampling effect during the fieldwork (Raguso & Gloster, 1993). Species number increased sharply right after the initiation of this survey and slowed down afterwards, finally reaching an asymptote.

The taxonomic and faunal compositions documented illustrate the general faunal characteristics of the butterflies on Xishan Hill. Compared with previous records, more swallowtails and danaines were collected with fewer pierids, nymphalines, and riodinids. Two reasons for this phenomenon are possible: 1) recent butterfly manuals recognizing more species that now occur in Yunnan than earlier (Lee, 1995; Huang, 1987; Chou, 1994) and/or 2) tourist development extended the walking trails so more areas

could be surveyed than before. These species include: *Byasa hedistus*, which is similar to *B. polyeuctes* except an extra white spot on hind wing (Wu, 2001; Chou, 1998), *Papilio syfanius*, *P. protenor*, *P. machaon*, *P. helenus*, *Graphium cloathus*, *Catopsilia promona*, *Appias remedies*, *Hebomoia glaucippe*, and *Tirumala septentrionis*.

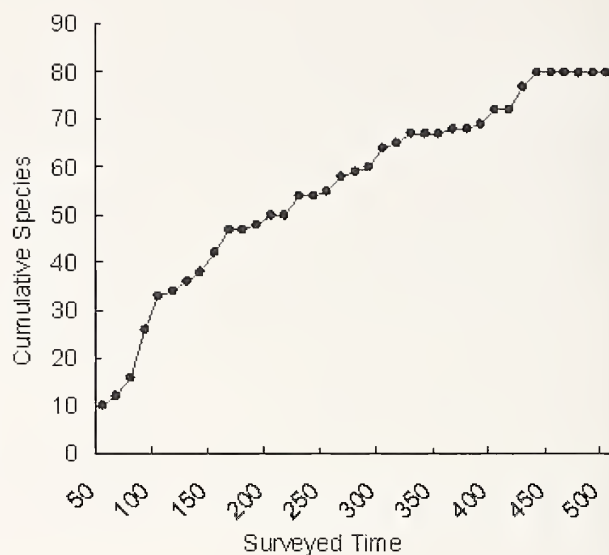
Eight species on the survey checklist are listed on the "China Species Red List (IUCN List)," with categories of NT and VU. During the survey, all eight species were abundant on the hill within their preferred habitats. The major reason they had been listed was their limited distributional ranges: *Ypthima iris* and *Y. dromon* are the only two endemic (to Yunnan) species on Xishan Hill, *Y. sakra* and *Y. nikaia* are distributed only in Yunnan and some adjacent

Table 5. Species collected or observed on non-floral materials.

| Butterfly species | Attractans | | | |
|----------------------------------|------------|-------|--------|------------------|
| | Mud | Feces | Fruits | Other |
| <i>Byasa polyenetes</i> | | | | X ² |
| <i>Papilio bianor</i> | X | | | X ² |
| <i>Pontia daplidice</i> | X | | | |
| <i>Delias belladonna</i> | X | | | |
| <i>Lethe andersoni</i> | | | X | |
| <i>Lethe duwa</i> | X | | X | |
| <i>Lethe verma</i> | X | | X | X ¹ |
| <i>Neope yama</i> | X | X | X | X ¹ |
| <i>Callerebia surioia</i> | X | X | | X ¹ |
| <i>Ypthima zodia</i> | X | X | | X ¹ |
| <i>Ypthima medusa</i> | X | X | | X ¹ |
| <i>Vanessa cardui</i> | X | | X | X ³ |
| <i>Vanessa indica</i> | X | X | X | X ^{1,3} |
| <i>Aglais urticae</i> | | | | X ¹ |
| <i>Issoria lathonia</i> | X | | | |
| <i>Neptis hylas</i> | X | | | |
| <i>Junonia orithya</i> | X | | X | |
| <i>Kaniska canace</i> | X | | X | |
| <i>Acraea issoria</i> | X | | | |
| <i>Dodona durga</i> | X | | | X ¹ |
| <i>Dodona onida</i> | X | | | |
| <i>Heliophorus brahma</i> | X | | | X ¹ |
| <i>Zizina otis</i> | X | X | | |
| <i>Alibergia chalcidus</i> | X | | | |
| <i>Lampides boeticus</i> | X | | | |
| <i>Celastrina oreas</i> | X | X | | |
| <i>Carterocephalus alcinoide</i> | X | | | |
| <i>Pelopidas agna</i> | X | | | |
| <i>Lobocla proxima</i> | X | | | |

Other objects including: 1. organic wastes dumped by tourists (food and fruit skin), 2. water, 3. tree fluid.

Asian countries (Sikkim, Bhutan, Nepal, and India). *Byasa hedistus* lives only in Yunnan and Fujian Province according to existing records. *Lethe andersoni* occurs only in Yunnan and Sichuan. *Lobocla proxima* is also found only in Yunnan and Sichuan Province. *Hebomoia glauccipe* has a wider occurrence, but illegal collecting has threatened the species (Wang and Xie, 2005). Five species of eight are Chinese endemics. All of them live in a very limited range within Chinese territory, resulting in compressed habitats that are vulnerable

**Figure 5.** Cumulative species numbers during the survey.

to human and natural disturbance. These species need protection with further knowledge about their biology and ecology needed. Under any circumstance, future conservation must focus on habitat protection (Kondla *et al.*, 1999).

Distinctive adult active periods were observed, with a clear gap between spring and summer generations. The reason for the phenomenon is that the spring generation's adults went through courtship, mating, and reproduction in the late spring or early summer and afterwards their numbers declined. Time is necessary for the next generation to develop and thus fewer adults were seen than in the prior period. After May, the summer generation adults emerged and numbers recovered. Some groups did not show evident gaps because of their large populations and generation overlap. The peaks of adult active periods are from mid March to May, then late June to early October.

Strong habitat affinities were demonstrated by the survey. Type 2 and 5 habitats are the most favored as a result of high plant diversity. Dense forests have high plant diversity, but insufficient sunlight reduces butterfly abundance. Farmland provides good nectar resources while monocultural plantations decrease butterfly abundance significantly, especially nymphalines, (Bobo *et al.*, 2006). Patches of farmland provide agricultural plants that host *Pieris spp.* and *Colias spp.*, are thus man-made habitats for these species.

Feeding habits were indicated by surveying preferred nectar plants and non-floral attractants.

Among plants, Asteraceae are most favored, but various butterflies visit different species of nectar source plants. This phenomenon implies an obligate relationship between butterflies and plants, supporting the viewpoint of previous behavior research. Butterflies are thus able to select nectar source plants instead of being opportunists when visiting flowers for food (Bhuyan *et al.*, 1999). Among non-floral attractants, mud is preferred, with most attracted butterflies taking water and mineral salts from there (Preston-Mafham & Rod, 1988; Lee & Zhu, 1996). Rotting fruits and other organic matter were the second favored attractants; the organic matter produced providing nutrition. Feces were only used by a few satyrines and nymphalines.

Taken together, the butterflies on Xishan Hill are a representative community of the Yunnan butterfly fauna. It is hoped that this survey will provide a benchmark for the future research and conservation.

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APPENDIX 1: Checklist of collected butterflies and corresponding habitat types.

| Species | Elevation | Fauna* | Habitat** |
|--------------------------------------|-------------|--------|------------|
| Papilionidae | | | |
| <i>Byasa hedistus</i> (Jordan) | 2,270-2,340 | O | 2 |
| <i>Byasa nevillei</i> (Wood-Mason) | 2,180-2,340 | O | 2, 5, 7, 8 |
| <i>Byasa polyeuctes</i> (Doubleday) | 2,100-2,340 | C | 2, 5, 7, 8 |
| <i>Papilio polytes</i> Linnaeus | 2,280-2,340 | C | 2, 5, 8 |
| <i>Papilio helenus</i> Linnaeus | 2,050-2,270 | O | 2, 8 |
| <i>Papilio protenor</i> Cramer | 2,000-2,280 | C | 5 |
| <i>Papilio xuthus</i> Linnaeus | 1,900-2,340 | C | 2, 5 |
| <i>Papilio bianor</i> Cramer | 1,900-2,340 | C | 5, 8 |
| <i>Papilio syfanius</i> Oberthür | 2,280-2,340 | O | 2, 5 |
| <i>Graphium cloanthus</i> (Westwood) | 1,900-2,170 | C | 2, 5, 7, 8 |

| Species | Elevation | Fauna* | Habitat** |
|--|-------------|--------|------------|
| Pieridae | | | |
| <i>Colias erate</i> Esper | 2,010-2,340 | C | 4, 5 |
| <i>Colias fieldii</i> Ménétrières | 2,010-2,340 | C | 4, 5, 8 |
| <i>Catopsilia pomona</i> (Fabricius) | 1,900-2,340 | O | 2 |
| <i>Eurema laeta</i> (Boisduval) | 1,900-2,340 | C | 4, 5 |
| <i>Eurema hecabe</i> (Linnaeus) | 1,900-2,340 | C | 2, 5 |
| <i>Gonepteryx amintha</i> Blanchard | 2,170-2,340 | C | 2, 4, 5 |
| <i>Gonepteryx rhamni</i> (Linnaeus) | 2,030-2,220 | C | 2, 4 |
| <i>Ixias pyrene</i> (Linnaeus) | 1,900-2,190 | O | 5 |
| <i>Delias belladonna</i> (Fabricius) | 2,280-2,340 | C | 2, 7, 8 |
| <i>Appias remedios</i> Schröder et Treadaway | 2,300 | O | 4, 5 |
| <i>Pieris brassicae</i> (Linnaeus) | 1,900-2,340 | P | 2, 5 |
| <i>Pieris melete</i> Ménétrières | 1,900-2,340 | C | 4, 5 |
| <i>Pieris rapae</i> (Linnaeus) | 1,900-2,340 | C | 4, 5 |
| <i>Pieris napi</i> (Linnaeus) | 1,900-2,340 | P | 4, 5 |
| <i>Aporia agathon</i> (Gray) | 2,170-2,290 | O | 4, 5 |
| <i>Pontia daplidice</i> (Linnaeus) | 2,170-2,340 | C | 4, 5 |
| <i>Hebomoia glaucippe</i> (Linnaeus) | 1,900-2,020 | O | 2, 5 |
| Danainae | | | |
| <i>Danaus chrysippus</i> (Linnaeus) | 2,300 | C | 5 |
| <i>Danaus genutia</i> (Cramer) | 2,170-2,300 | O | 2, 5 |
| <i>Tirumala septentrionis</i> (Butler) | 2,170-2,340 | O | 1, 2, 5 |
| <i>Parantica sita</i> (Kollar) | 2,000-2,340 | C | 5 |
| <i>Parantica melanea</i> (Cramer) | 2,000-2,340 | O | 2, 5 |
| <i>Euploea mulciber</i> (Cramer) | 2,280-2,340 | O | 2 |
| Satyrinae | | | |
| <i>Melanitis leda</i> (Linnaeus) | 1,900-2,120 | C | 1, 2, 5, 9 |
| <i>Lethe andersoni</i> (Atkinson) | 2,000-2,110 | O | 1, 2, 9 |
| <i>Lethe dura</i> (Marchall) | 2,230 | O | 5, 6, 9 |
| <i>Lethe verma</i> (Kollar) | 1,900-2,270 | O | 5, 9 |
| <i>Neope yama</i> (Moore) | 2,220 | C | 2, 5, 9 |
| <i>Ypthima balda</i> (Fabricius) | 2,170-2,340 | C | 2, 5, 9 |
| <i>Ypthima iris</i> Leech | 2,170-2,340 | E | 2, 5, 9 |
| <i>Ypthima dromon</i> Oberthür | 2,200-2,300 | E | 2, 5, 9 |
| <i>Ypthima nikaia</i> Moore | 2,170 | O | 2, 5, 9 |
| <i>Ypthima sakya</i> Moore | 2,170-2,340 | O | 1, 9 |
| <i>Ypthima zodia</i> Butler | 2,170-2,340 | O | 2, 9 |
| <i>Ypthima medusa</i> Leech | 2,170-2,340 | O | 1, 9 |
| <i>Callerebia suroia</i> Tytler | 2,170-2,340 | O | 2, 5, 9 |
| Nymphalinae | | | |
| <i>Cethosia biblis</i> (Drury) | 2,260 | O | 5 |
| <i>Vanessa cardui</i> (Linnaeus) | 2,100-2,340 | C | 2, 3, 5, 8 |
| <i>Vanessa indica</i> (Herbst) | 2,100-2,340 | C | 2, 3, 5, 8 |

| Species | Elevation | Fauna* | Habitat** |
|---|-------------|--------|---------------|
| <i>Ariadne ariadne</i> (Linnaeus) | 2,200-2,250 | C | 2, 3, 5, 6 |
| <i>Kaniska canace</i> (Linnaeus) | 2,250 | C | 2, 3, 4, 5, 6 |
| <i>Aglais urticae</i> (Linnaeus) | 2,180-2,340 | P | 2, 4 |
| <i>Junonia orithya</i> (Linnaeus) | 2,130-2,260 | C | 5, 6 |
| <i>Junonia hierta</i> (Fabricius) | 2,120-2,300 | O | 5, 6 |
| <i>Symbrenthia hypselis</i> (Godart) | 1,980-2,000 | O | 2 |
| <i>Phalanta phalantha</i> (Drury) | 2,230-2,300 | O | 2, 4, 5 |
| <i>Issoria lathonia</i> (Linnaeus) | 1,900-2,300 | C | 2, 5 |
| <i>Argyreus hyperbius</i> (Linnaeus) | 2,170-2,340 | C | 1, 2, 5 |
| <i>Chilodreia childreni</i> (Gray) | 2,170-2,340 | C | 2 |
| <i>Melitaea yuenty</i> Oberthür | 2,030-2,340 | O | 2 |
| <i>Neptis hylas</i> (Linnaeus) | 2,170-2,300 | O | 2, 3, 5 |
| <i>Athyma opalina</i> (Kollar) | 2,300 | O | 2 |
| <i>Calinaga buddha</i> Moore | 2,190-2,340 | O | 2 |
| Acraeinae | | | |
| <i>Acraea issoria</i> (Hübner) | 2,240-2,300 | O | 2, 5 |
| Riodinidae | | | |
| <i>Dodona durga</i> (Kollar) | 2,130-2,340 | O | 2, 5, 9 |
| <i>Dodona ouida</i> Moore | 1,900-2,340 | O | 1, 2, 5, 8, 9 |
| Lycaenidae | | | |
| <i>Lampides boeticus</i> (Linnaeus) | 1,900-2,340 | C | 1, 2, 4, 5, 8 |
| <i>Celastrina oreas</i> (Leech) | 1,900-2,340 | O | 2, 4, 5, 6, 7 |
| <i>Zizina otis</i> (Fabricius) | 2,170-2,340 | O | 6 |
| <i>Heliophorus brahma</i> Moore | 2,010-2,340 | O | 3, 6 |
| <i>Tongeia ion</i> (Leech) | 2,180 | C | 2, 5 |
| <i>Ahlbergia chalcidis</i> (Leech) | 2,170-2,300 | O | 4, 5 |
| <i>Jamides bochus</i> Cramer | 2,300 | O | 2 |
| Hesperiidae | | | |
| <i>Chaospes benjaminii</i> (Guérin-Ménéville) | 2,130 | O | 8 |
| <i>Potanthus pallida</i> (Evans) | 2,290-2,340 | O | 2 |
| <i>Carterocephalus alcinoide</i> Lee | 2,100-2,340 | P | 5 |
| <i>Pelopidas agna</i> (Moore) | 2,250 | O | 8 |
| <i>Lobocla proxima</i> (Leech) | 2,300 | O | 1, 2, 3 |
| <i>Ochlodes subhyalina</i> (Bremer et Grey) | 2,180-2,340 | C | 1, 2 |
| <i>Pyrgus maculatus</i> (Bremer et Grey) | 2,180 | P | 5 |

* The letters in the **Fauna** column represent one of four butterfly fauna areas: **O**: Oriental Region, **P**: Palearctic Region, **C**: cosmopolitan, **E**: endemic to Yunnan.

** The numbers in the **Habitat** column represent the nine habitat types classified in this study.